

**Claims**

That which is claimed:

1. A method of forming a metal contact in a semiconductor device, comprising:
  - 5 forming an insulating layer having a contact hole therein on a silicon substrate;
  - forming a cobalt layer on a bottom and inner walls of the contact hole;
  - forming a cobalt silicide layer at the bottom of the contact hole while forming a titanium layer on the cobalt layer; and
  - forming a plug on the titanium layer so as to fill the contact hole.
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2. The method of Claim 1, wherein the plug comprises titanium nitride.
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3. The method of Claim 1, further comprising:
  - forming a titanium nitride layer on the titanium layer; and
  - wherein forming the plug comprises:
    - forming the plug on the titanium nitride layer so as to fill the contact hole.
4. The method of Claim 3, wherein the titanium nitride layer has a thickness of about 50 to 500 Å.
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5. The method of Claim 4, wherein the titanium nitride layer is formed using chemical vapor deposition (CVD) at a temperature of about 400 to 750°C
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6. The method of Claim 3, wherein the plug comprises at least one of tungsten, titanium nitride, aluminum, and tantalum nitride.
7. The method of Claim 3, wherein the cobalt layer, the titanium layer, and the titanium nitride layer are formed in situ without a vacuum break.
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8. The method of Claim 1, wherein the cobalt layer has a thickness of about 5 to 200 Å.

9. The method of Claim 1, wherein the cobalt layer is formed using one of physical vapor deposition (PVD) and chemical vapor deposition (CVD).

10. The method of Claim 9, wherein the cobalt layer is formed using PVD  
5 at a temperature of about 25 to 500°C.

11. The method of Claim 1, wherein the titanium layer has a thickness of about 5 to 150 Å.

10 12. The method of Claim 1, wherein the titanium layer is formed using chemical vapor deposition (CVD) at a temperature of about 400 to 750°C.

13. The method of Claim 1, wherein substrate and insulating layer are cleaned after forming the insulating layer.

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14. A method of forming a metal contact in a semiconductor device, comprising:

forming an insulating layer having a contact hole therein on a silicon substrate;  
forming a cobalt layer on a bottom and inner walls of the contact hole;

20 forming a cobalt silicide layer at the bottom of the contact hole while forming a titanium nitride layer on the cobalt layer; and

forming a plug on the titanium nitride layer so as to fill the contact hole.

15. The method of Claim 14, wherein the titanium nitride layer has a  
25 thickness of about 50 to 150 Å.

16. The method of Claim 14, wherein the titanium nitride layer is formed using chemical vapor deposition (CVD) at a temperature of about 400 to 750°C

30 17. The method of Claim 14, wherein the plug comprises at least one of tungsten, titanium nitride, aluminum, and tantalum nitride.

18. The method of Claim 14, wherein the cobalt layer and the titanium nitride layer are formed in situ without a vacuum break.

19. The method of Claim 14, wherein the cobalt layer has a thickness of  
5 about 5 to 200 Å.

20. The method of Claim 14, wherein the cobalt layer is formed using one of physical vapor deposition (PVD) and chemical vapor deposition (CVD).

10 21. The method of Claim 20, wherein the cobalt layer is formed using PVD at a temperature of about 25 to 500°C.

22. The method of Claim 14 wherein substrate and insulating layer are cleaned after forming the insulating layer.

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23. A method of forming a metal contact in a semiconductor device, comprising:

20 forming an insulating layer having a contact hole therein on a silicon substrate; forming a cobalt layer on a bottom and inner walls of the contact hole; and forming a cobalt silicide layer at the bottom of the contact hole while forming a plug that fills the contact hole on the cobalt layer.

24. The method of Claim 23, wherein the plug comprises titanium nitride.

25 25. The method of Claim 24, wherein the plug has a thickness of about 20 to 3000 Å.

26. The method of Claim 23, wherein the cobalt layer and the plug are formed in situ without a vacuum break.

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27. A method of forming a metal contact in a semiconductor device, comprising:

forming an insulating layer having a contact hole therein on a silicon substrate;

forming a titanium layer on a bottom and inner walls of the contact hole;  
forming a cobalt layer on the titanium layer;  
forming a complex silicide layer comprising titanium silicide and cobalt  
silicide at the bottom of the contact hole while forming a titanium nitride layer on the  
5 cobalt layer; and  
forming a plug on the titanium nitride layer so as to fill the contact hole.

28. The method of Claim 27, wherein the plug comprises at least one of tungsten, titanium nitride, aluminum, and tantalum nitride.

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29. The method of Claim 27, wherein the titanium nitride layer has a thickness of about 50 to 500 Å.

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30. The method of Claim 27, wherein the titanium nitride layer is formed using chemical vapor deposition (CVD) at a temperature of about 400 to 750°C

31. The method of Claim 27, wherein the titanium layer, the cobalt layer, and the titanium nitride layer are formed in situ without a vacuum break.

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32. The method of Claim 27, wherein the cobalt layer has a thickness of about 5 to 200 Å.

33. The method of Claim 27, wherein the cobalt layer is formed using one of physical vapor deposition (PVD) and chemical vapor deposition (CVD).

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34. The method of Claim 33, wherein the cobalt layer is formed using PVD at a temperature of about 25 to 500°C.

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35. The method of Claim 27, wherein the titanium layer has a thickness of about 5 to 150 Å.

36. The method of Claim 27, wherein the titanium layer is formed using chemical vapor deposition (CVD) at a temperature of about 400 to 750°C.

37. The method of Claim 27, wherein substrate and insulating layer are cleaned after forming the insulating layer.

5 38. A method of forming a metal contact in a semiconductor device, comprising:

forming an insulating layer having a contact hole therein on a silicon substrate;

forming a titanium layer on a bottom and inner walls of the contact hole;

forming a cobalt layer on the titanium layer; and

10 forming a complex silicide layer comprising titanium silicide and cobalt silicide at the bottom of the contact hole while forming a plug that fills the contact hole on the cobalt layer.

39. The method of Claim 38, wherein the plug comprises titanium nitride.

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40. The method of Claim 39, wherein the plug has a thickness of about 20 to 3000 Å.

41. The method of Claim 38, wherein the titanium layer, the cobalt layer, 20 and the plug are formed in situ without a vacuum break.